

toed. On the other hand, I have been quite unable to detect even a trace of it in some such birds, as *e. g.* *Rhea*, *Tetrax*, and *Pelecanoides*."

Prof. Owen, C.B., F.R.S., F.Z.S., read the twenty-fourth of his series of memoirs on the extinct birds of the genus *Dinornis* and their allies. The present memoir contained the description of the head and two feet with the dried integuments attached, of an individual of a species of *Dinornis*, proposed to be called *D. didinus*, which had been recently obtained from a cavern or fissure near Queenstown, in the South Island of New Zealand.

This memoir will be printed entire in the Society's 'Transactions.'

The following papers were read:—

1. On the Valves of the Heart of *Ornithorhynchus paradoxus* compared with those of Man and the Rabbit, with some Observations on the Fossa Ovalis. By E. RAY LANKESTER, M.A., F.R.S., Jodrell Professor of Zoology in University College, London¹.

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(Plates XXXVIII.—XLI.)

The statement current in text-books of Comparative Anatomy to the effect that in *Ornithorhynchus paradoxus* the right auriculo-ventricular valve is "fleshy," and therefore in some degree similar to that of Reptiles and Birds and different from that of other Mammalia, appears to rest chiefly upon the statements and figures of Meckel, published in his Monograph of the Anatomy of the Duck-bill, though Cuvier, Owen, and Gegenbaur have also made observations on the subject. No anatomist appears to have published any drawing of the heart of *Ornithorhynchus* since Meckel in 1828; and no figure has ever been given of the interesting points of structure presented by that heart which is in any sense adequate. The figure of the opened heart given by Meckel, and intended to show the fleshy auriculo-ventricular valve, is simply unintelligible owing to the absence of both shading and colour.

Meckel describes the right auriculo-ventricular valve in these words:—"Ostium venosum valvulâ clauditur simplici, semilunari. Cuvierus eam nonnisi concavo ventriculi pariete respondere dicens, minus perspicue loqui videtur, quum uterque, et anterior s. dexter, et posterior s. sinister, a septo formatus, convexi sint. Ille revera

¹ I am indebted to Mr. J. J. Quelch, B.Sc., lately my assistant, and now one of the staff of the British Museum, for aid in making the drawings and dissections upon which this memoir is based.

obvertitur et insidet margine fixo. Recte a Cuvierio maxima ex parte carnea dicitur, quum nonnisi pars libera, anterior, margine leviter concavo circumscripta, membranacea sit. Fasciculi musculares, ad ipsam et e septo et e pariete antico tendentes ad tres ordines reduci possunt. Inferior, major, e pluribus fasciculis componitur ex septo medio infero ad extremum valvulæ inferius abit, anterior ex parietis anterioris parte inferiore recte ad basin valvulæ ascendit, ubi cum superiore, ex summitate septi descendente confluit."

Owen, in the article *Monotremata* in Todd's *Cyclopædia*, vol. iii. p. 390, describes the valve somewhat differently. He distinguishes two fleshy and two membranous portions—the smaller of the latter, placed near the base of the pulmonary artery, agreeing according to him with the smaller muscular fold of the *Cursores*, whilst the second larger fleshy mass is homologous with the chief muscular valve of the Bird's heart.

Gegenbaur ("Zur vergleichenden Anatomie des Herzens," *Jenaische Zeitschrift*, 1866, vol. ii. p. 381) objects to this identification, although he practically admits something very much like it in comparing the valve of *Ornithorhynchus* to that of the Crocodile, which, in its turn, may be readily shown to have common features with that of the Bird. In his 'Elements of Comparative Anatomy,' English edition, p. 584, Gegenbaur speaks of the fleshy structure of the heart of *Ornithorhynchus* as being a retention in this animal of a condition which is not unknown in other Mammalia, but is transient in them, being found at an early period of development.

In his memoir in the '*Jenaische Zeitschrift*,' Gegenbaur gives an original description of the right auriculo-ventricular valve of *Ornithorhynchus*, but no figure of it. His description does not agree with that of his predecessors, nor with what I have observed. He says:—"I find the entire circumference of the right atrio-ventricular ostium beset by a membranous valve, which has developed muscular bundles only at certain parts, and is disposed, as the following account shows, somewhat otherwise than Meckel and Owen have stated. Two portions may be distinguished in this valve—a part adjacent to the ventricular septum, and a part which fringes the ostium along the outer wall of the ventricle. The two portions posteriorly pass into one another, and anteriorly, in the neighbourhood of the origin of the pulmonary artery (that is, at the *conus arteriosus*), are separated from one another, inasmuch as here a spot is found in the circumference of the ostium in which the valve is interrupted." [This does not accord with the previous statement as to the "entire" circumference being beset with the valve. As will be seen below, in the hearts examined by me a very large part of the circumference of the ostium is devoid of any valve.] "The portion of the valve corresponding to the outer ventricular wall begins broadly at the *conus arteriosus* (or anteriorly); it stretches outwards and backwards, becoming broader, and then narrows again and passes into the median division of the valve. At the anterior point of fixation of the valve, two strong muscular bundles pass from the ventricular septum into the valve, and run (the heart being supposed to have its

apex directed backwards) in a nearly horizontal direction in the valve. They occupy, however, scarcely the third part of the entire length of this division of the valve. At the broadest part of this same division a muscular band passes from the ventricular septum, and is inserted into the former, and spreads its fibres in a fan-like expanse in the valve nearly up to the origin of the valve from the margin of the ostium. A second smaller bundle lies behind this, also arising from the septum. If we spread out the valve, and compare the purely membranous surface with that provided with muscular tissue, the former is found to be larger than the latter. The second portion of the valve arises from the part of the ostium belonging to the septum. At its narrower part it is in continuity with the other division of the valve, broadens out from behind forwards, and is fastened to the septum along a perpendicular line stretching from the ostium into the ventricle. It is therefore not only fastened to the circumference of the ostium, but, starting from there, also to the septum. Since the latter line of fixation is perpendicular to the line of origin along the ostium, this portion of the valve forms a 'pocket-valve'—the more so since no trabeculæ pass to its free margin, and moreover no muscular fibres can be detected in its substance.

"When a comparison of this arrangement is made with that of Birds, the difficulty is at once obvious that in *Ornithorhynchus* the septal portion of the ostium has a valve, whilst such is wanting in Birds. The whole apparatus cannot, therefore, be compared with that of Birds, but only the portion of the valve which arises from the outer half of the circumference of the ostium."

In the absence of figures it is not possible fully to comprehend Professor Gegenbaur's description; but it seems to me probable that the heart examined by him differed individually from those studied by Meckel and Cuvier, and from the two examined by me. In these two, as will be seen below, considerable differences were observed on comparison one with another.

The main point on which Gegenbaur insists, is the existence of a septal portion to the valve; it is on this account that he objects to a comparison with the Bird's valve. But this septal portion seems to have been exceptionally large in the heart studied by him. In both my specimens it was small, and left the *larger part of the septal margin of the ostium unprovided with any valvular fold*. At the same time it was larger in one specimen than in the other. The existence of a greater or less portion of the valve along the septal side of the ostium does not appear to invalidate the comparison of the main bulk of the valvular structure with that of the Bird's heart, though the closeness of the agreement is diminished by the fact insisted on by Gegenbaur, viz. that the muscular bands of the valve arise in *Ornithorhynchus*, as in the Crocodile, from the septal wall of the ventricle, and not from the free outer wall as in the Birds.

Recognizing, as all anatomists must do, the great interest attaching to the observation that in *Ornithorhynchus* muscular tissue to a large extent invades and replaces the membranous structure which

characteristically forms the right auriculo-ventricular valve in other Mammals, I have taken an opportunity of carefully examining and drawing the valves and some other structural features seen in the hearts of two specimens of *Ornithorhynchus* presented to me by my friend Professor Liversidge, of Sydney, Australia.

The main object of the present communication is to publish satisfactory illustrations, with explanatory description, of the appearances presented by these two hearts. I cannot doubt that both anthropotomists and zoologists will be glad to possess something like a sufficient record of the very important facts observable in the heart of *Ornithorhynchus*; and I have added for comparison drawings of identical dissections viewed in corresponding positions of the "standard" heart (that of Man) and of the heart of the Rabbit, which, curiously enough, differs more from that of Man in respect of the structure of its right auriculo-ventricular valve than does that of the sheep, the ox, the dog, the hedgehog, the great ant-eater, the wombat, and the koala, which I have examined with especial reference to this point, and some of which are illustrated in the plates.

For several interesting hearts I am indebted to the kindness of Mr. W. A. Forbes, Prosector to the Society.

I shall first describe the figures accompanying this paper which illustrate the comparative structure of the right auriculo-ventricular valve of Man, the Rabbit, and *Ornithorhynchus*; I shall then describe the left auriculo-ventricular valve of *Ornithorhynchus*; and finally point out some peculiarities in the structure of the auricles of the heart of that animal, which have led to the erroneous statement that it possesses a deeply marked "fossa ovalis."

THE RIGHT AURICULO-VENTRICULAR VALVE.

A. OF MAN.—From the tendinous margin of the right auriculo-ventricular orifice of the human heart depends into the ventricle a complete and continuous membranous collar (Pl. XXXVIII. figs. 1 & 2). This is the so-called tricuspid valve. It derives its name from the fact that, although forming one continuous collar-like ring, the membrane is produced at three points, forming three cusps or flaps.

Two of these cusps are anterior in position, and may be called right and left anterior cusps¹ (*r a c*, *l a c* in the figures). The third is wider than the two anterior, and rests against the septum or wall separating right from left ventricle; it may be called the posterior or septal cusp (*p c*).

The three cusps of the tricuspid valve of Man are attached by fine chords (the "chordæ tendineæ") to definite muscular lobes (the "musculi papillares") projecting from the ventricular wall, and also by some of the chordæ directly to the ventricular wall.

The two anterior cusps of the valve are in relation with the largest muscular lobe or musculus papillaris, which springs from the septal surface near the apex of the ventricular chamber (fig. 1, *a*). The long

¹ The "inferior" and "anterior" of human anatomists. In the present memoir the apex of the heart is regarded as inferior, the base as superior, the dorsal surface as posterior, the ventral surface as anterior.

axis of this lobe would, if produced, pass between the two anterior cusps in the notch which separates them. Right and left two groups, each of four or more chordæ tendineæ, pass from the free end of this papillary muscle, and, spreading out fan-wise, join respectively the right and the left cusps of the membranous valve; so that the adjacent margins of the two cusps are connected by groups of chordæ to the papillary muscle; and were the groups of chordæ to be enlarged and fuse with one another, we should have in place of a right and a left anterior cusp one large anterior cusp connected by the most prominent portion of its border to the papillary muscle. This hypothetical condition is realized in *Ornithorhynchus*.

The large papillary muscle thus related in Man to the right and left anterior cusps of the tricuspid valve, is the "great" or "anterior" papillary muscle.

The right border or curvature of the right anterior cusp is connected by chordæ tendineæ to a small papillary muscle, which may be called the "right papillary muscle" (figs. 1 & 2, b).

The left border or curvature of the left anterior cusp is connected by chordæ directly to the wall of the ventricle, to the right of that region which is known as the pulmonary cone (figs. 1 & 2, e).

The septal cusp or segment of the tricuspid valve of Man may be regarded as really the posterior equivalent of both anterior cusps, not divided or produced into two pieces. It is connected to the septal wall of the ventricle directly by chordæ tendineæ, and also to two small papillary muscles which project from that wall (fig. 2, c, d), and may be known as the posterior or septal papillary muscles (greater and less). These are smaller than the right papillary muscle; and all the other papillary muscles are much smaller than the "great" or "anterior" papillary muscle.

B. OF THE RABBIT.—Whilst a large number of mammals possess a tricuspid valve very closely similar in its arrangements to that of Man (see Pl. XLI. figs. 18–22), in the Rabbit (Pl. XXXVIII. figs. 3, 4) a considerable divergence from the human standard occurs.

The valve of the right side of the Rabbit's heart cannot be described as "tricuspid" in any sense. It is a continuous membranous collar connected by numerous chordæ tendineæ to two rows of muscoli papillares. The valvular collar is elliptical in form; and it may be divided into an anterior and a posterior (or septal) portion corresponding to the two long sides of the ellipse.

The two rows of muscoli papillares are arranged along the septal portion of the ventricular wall as a superior and an inferior series. The superior series are connected by chordæ tendineæ with the posterior or septal half of the valve; the inferior series are connected by chordæ with the anterior half of the valve.

There are seven muscoli papillares in the inferior series belonging to the anterior part of the valve¹. Those of the superior series, belong-

¹ Since the above was written I have found that great variations occur in the points described in individual Rabbits. Often the muscoli papillares are not more than three in number, as in the figure of a Rat's ventricle (Plate XXXIX. fig. 11).

ing to the septal part of the valve, are smaller in size, and in passing from left to right dwindle, so that at the right of the middle line the chordæ are inserted directly into the ventricular wall and not into papillary eminences. Only three distinct papillary eminences can be distinguished in this series.

Comparing this arrangement with that found in Man, it is obvious that the seven papillary muscles of the anterior part of the valve correspond to the "great" and the "right" anterior papillary muscles of Man; whilst the superior series connected with the septal part of the valve correspond to the posterior papillary muscles of Man. But in the Rabbit not only must we consider that the "great" and the "right" papillary muscles are divided and represented each by three separate papillary muscles, but also that the attachment of chordæ springing from the extreme left of the left anterior cusp and from the left of the septal cusp in the human heart, are in the Rabbit attached to small papillary elevations of muscular substance, instead of being attached simply to the unraised surface of the ventricular wall.

It is an interesting question as to whether the condition found in Man and in most mammals is more primitive than that found in the Rabbit. The fact that the Rodents are lower forms than the Simiæ might lead us to regard the condition seen in the Rabbit as more primitive; but the very general conformity of the other Mammalia (including such Marsupials and Edentata as have been examined) to the arrangement found in Man, leads to the supposition that the Rabbit's right cardiac valve is a specialization departing from the earlier type preserved in Man.

This conclusion will be found to be confirmed by the facts which we now shall expose in reference to the right cardiac valve of *Ornithorhynchus*.

C. OF ORNITHORHYNCHUS PARADOXUS.—The right auriculo-ventricular valve of *Ornithorhynchus* is drawn in two sets of figures, accompanying this paper (Plates XXXIX., XL.), taken from the two female specimens in an excellent state of preservation mentioned above. In both of them the membranous collar which forms the complete valve in other Mammalia is seen to be incompletely developed, and not "entire" as stated by Gegenbaur. Instead of the elliptical auriculo-ventricular orifice being completely fringed by the more or less deeply dependent valve, we find only its anterior margin and a small portion of its posterior or septal margin (the extreme right) thus fringed. The septal or posterior portion of the valve is, in fact, almost entirely wanting in one of my specimens (fig. 16). This result of my observations is diametrically in opposition to the statements of Gegenbaur quoted at the commencement of this memoir.

The absence of the greater part, or even the whole, of the septal flap at once constitutes a very important difference between the right cardiac valve of *Ornithorhynchus* and that of any other Mammal which is known.

Anterior flap.—The well-developed anterior portion of the membranous valve is triangular in form, and is connected with a very large muscular column, which for convenience may be spoken of as *musculus*

papillaris, although not "papillary" (figs. 12 & 13, *a*). It obviously corresponds to the great or anterior papillary muscle of the human heart. The vertex of the triangle formed by the membranous flap of the valve is bisected by this great papillary muscle, which widens out as it passes upwards, and is inserted into the anterior border of the auriculo-ventricular ring, thus dividing the membranous triangular flap into two distinct pieces, a right and a left. It is therefore perhaps not quite correct to speak of these two segments united by the muscular band as *one* anterior flap: the flap might perhaps be regarded as composed of *two* membranous segments united by a median muscular band which is the prolonged anterior papillary muscle. The membranous substance of the valve, however, is distinctly continued beneath or on the lumen side of the muscular band, thus uniting the two halves, which at first sight seem to be separated by the muscular substance. Obviously the right segment corresponds to the right anterior cusp, and the left segment to the left anterior cusp, of the human tricuspid valve.

The peculiarity of this region in *Ornithorhynchus* consists in the fact that there are no chordæ tendineæ connecting the membranous segments to the great papillary muscle, while the muscle itself is attached directly to the membranous flap, and is continued through it up to the auriculo-ventricular ring, so as to invade (over a broad band-like area) the membrane of the valve by muscular tissue.

There is also a complete absence of chordæ tendineæ from the left border of the left anterior flap, which is, in their absence, directly attached to a fleshy arch which extends from the side of the pulmonary cone up to the auriculo-ventricular ring, where it is confluent with the expanded insertion of the great papillary muscle (figs. 12, 13, 14, 15, *e*). Consequently the left membranous segment of the valve is triangular in shape, the free border forming the base of an isosceles triangle.

Both hearts examined agreed in the features so far described.

In regard to the connexions of the right membranous segment of the anterior portion of the valve, they differ a little from one another. In heart No. 1 (fig. 12) there is a well marked right papillary muscle (*b*) corresponding to the similarly placed muscle in Man, but differing from that of Man, just as does the great papillary muscle, in the fact that it is devoid of any chordæ tendineæ and is continued from the ventricular wall up to the auriculo-ventricular ring, having the right border of the right membranous cusp or segment attached directly to its left border in the upper part of its course.

Septal flap.—To the right or posterior border of this smaller muscular band in heart No. 1, one lateral border of the very small septal membranous flap is attached. This rudimentary posterior or septal flap arises along the posterior or septal margin of the auriculo-ventricular orifice for not more than one third of the extent of that margin, the rest being free from any valvular collar or fringe (figs. 14 & 15, *p c*).

The condition seen in heart No. 1 may be understood by supposing, in a valve arranged as in Man, the chordæ tendineæ to become muscular and compacted together and so to form parts of the

papillary muscles, which should then be continued right through the membranous collar of the valve to the auriculo-ventricular ring. Further, we should have to suppose the suppression of the whole of the septal division of the valve and its related chordæ and muscles, excepting a little piece in immediate relation with the right anterior papillary muscle.

The heart No. 2 (fig. 13) of *Ornithorhynchus* differs from No. 1 in the fact that there is not a single right anterior papillary muscle, but five separate muscular slips representing it, of which three (fig. 13, *b, b, b*) are attached to and traverse the membranous substance of the valve, whilst two (*m, n*) pass over it and reach the auriculo-ventricular ring. These latter are of great importance in the comparison with the heart of Sauropsida, since they arise from the anterior ventricular wall. The heart No. 2 is also remarkable, as already mentioned, for the reduction of the septal portion of the membranous valve to a vanishing quantity (fig. 16 *p c*).

In both hearts the three muscles of the valve (or two and the subdivided third) become continuous with one another at their insertion into the auriculo-ventricular ring. The large papillary muscle in the middle spreads out on either side, and on the left completes the arch formed by the muscular lobe (*e*) rising from the side of the pulmonary cone; on the right it similarly completes an arch, of which the right side is formed by the spreading insertion of the right papillary muscle or its representative slips (figs. 12, 13).

It is thus quite clear that the description of the right auriculo-ventricular valve of *Ornithorhynchus* as "fleshy" is quite correct; membrane, though present, plays a subordinate part as compared with what is seen in other Mammalia.

Not only this, but it seems probable, from the very imperfect development of a septal or posterior flap to the valve, that the action of the valve must differ importantly from that of the valve of other mammals, and resemble that of the fleshy valve of birds and reptiles.

The reflux of blood into the auricle on contraction of the ventricle is not prevented in *Ornithorhynchus* by a passive floating-out of membranous cusps, but, as in birds and reptiles, the muscular arches of the valve are by their active contraction pressed against the septal portion of the auriculo-ventricular orifice, which is for two thirds (or sometimes more) of its extent devoid of any depending cusp or membranous flap.

How far there is a real agreement, due to common inheritance from a common ancestor, between the muscular structures of the right cardiac valve of *Ornithorhynchus* and those of the similarly placed valve in birds and certain reptiles, is a distinct and very important question, into the discussion of which I do not propose to enter on the present occasion.

THE LEFT AURICULO-VENTRICULAR VALVE.

The valve which is called "mitral" in Man's heart differs in structure in *Ornithorhynchus* from the human standard, although much less so than does the right auriculo-ventricular valve.

The "mitral" valve of the *Ornithorhynchus* is in fact a "tricuspid" instead of a "bicuspid" valve. Its construction, so far as the relation of membrane to muscle is concerned, is similar to what is seen in Man's heart. There is no invasion of the membranous flaps by the fleshy substance of the muscoli papillares as on the right side of the heart; at the same time the connexion of the muscoli papillares with the membrane of the valvular flaps is *direct*, and not by the intervention of chordæ tendineæ.

In Man's mitral valve there are really *four* groups of chordæ which pass from the membrane to the heart's wall or to muscoli papillares. A broad flap of membrane is developed between the anterior pair of these groups of chordæ, and, again, between the posterior pair, but *not* between adjacent anterior and posterior groups.

In *Ornithorhynchus* the attachment of the membrane to the muscle is by three equidistant points of the valvular membranous collar to three elevations of the muscular substance of the ventricle; and, as shown in the figure (fig. 17), the membrane is equally developed in each of the three spaces between the attachments. It is thus divisible into three *areæ*, each having the form of a truncated triangle. The valve is indeed more nearly comparable in shape to the aortic trisegmented semilunar valves than to the mitral of the human anatomists. A very distinct and important point of resemblance between the left auriculo-ventricular valve of *Ornithorhynchus* and the semilunar valves at the base of the great arteries, is the existence of a small knob of cartilaginous consistence at the centre of the free margin of each triangular portion of the valve. These appear to have the same significance as the corpuscles of Arantius in the semilunar valves.

THE AURICLES OF ORNITHORHYNCHUS.

Meckel has remarked on the large size of the right auricle of *Ornithorhynchus* as compared with that of the left. He has also stated that there is a very deep fossa ovalis. In these statements Owen is in accord with him. Gegenbaur does not discuss this subject when treating of the right auriculo-ventricular valve. I find that the right auricle is of unusually large proportions in *Ornithorhynchus* (figs. 5 & 6), and have compared in the drawings given the proportions in this animal with those presented by the Rabbit.

In fact the right auricle is much larger than has been hitherto supposed; for what Meckel and Owen have taken for a *fossa ovalis* appears *not* to be the representative of that structure, but an independent and special cæcum of the right auricle by which it encroaches upon the area occupied in other animals by the left auricle. The orifice of this cæcum, seen on opening the anterior wall of the right auricle, is very sharply defined and of the size which the fossa ovalis might be expected to present (Plate XXXIX. fig. 8, *Cæ*). It is not, however, in the position proper to the fossa ovalis. It leads into an extensive sac; and at first I was under the impression that the sac in question was a part of the *left* auricle, and hence that we had here a permanent communication between the

two auricles. This, however, proved to be an erroneous anticipation. The extension of this angle of the right auricle, and the constriction into the form of an oval ring of the communication between it and the main cavity of the auricle, are sufficiently remarkable.

The site of the interauricular communication is not marked in the adult *Ornithorhynchus* by a fossa.

EXPLANATION OF THE PLATES.

PLATE XXXVIII.

Fig. 1. MAN. View of the tricuspid valve as seen on removing the anterior wall of the right ventricle.

a, great anterior papillary muscle; *b*, right or lesser anterior papillary muscle; *c*, greater septal or posterior papillary muscle; *d*, lesser septal or posterior papillary muscle; *e*, point of attachment of left anterior chordæ tendineæ, not developed as a papillary muscle; *rac*, right anterior cusp of the membrane of the valve; *lae*, left anterior cusp of the membrane of the valve.

2. MAN. The same view, but the great papillary muscle is now cut through, and the right and left anterior cusps of the valve are reflected so as to expose the auriculo-ventricular orifice and the septal cusp.

N.B. A dark background is introduced behind the chordæ tendineæ of the reflected cusps, by inadvertence of the lithographer.

Letters as in fig. 1, excepting *a'*, apex of the great papillary muscle, cut away from *a*. *p c*, posterior or septal cusp of the membrane of the valve.

3. RABBIT (*Lepus cuniculus*). View of the "tricuspid" valve similar to that given in fig. 1, showing the seven anterior papillary muscles, of which *a, a, a* represent the great papillary muscle of Man, whilst *b, b, b, b* represent the right or lesser anterior papillary muscle of Man, *e* corresponding with *e* in the human heart. *P. A*, pulmonary artery.

4. The same heart with the anterior papillary muscles cut through and the valve reflected, exposing the attachments *c, d* of the posterior or septal flaps. *a', a', a'*, apices of the larger anterior papillary muscles cut away from their bases and reflected; *b', b', b'*, apices of three of the smaller (right) anterior papillary muscles similarly cut away. Other letters as in fig. 3.

5 & 6. Diagrams of views of the basal aspect of the heart of *Ornithorhynchus* (fig. 5) and the Rabbit (fig. 6), intended to show the relative proportions and form of the right and left auricles, and especially the position of the cæcal appendix (*Cæ*) of the right auricle of *Ornithorhynchus*. Letters as in fig. 7.

PLATE XXXIX.

Fig. 7. ORNITHORHYNCHUS. Anterior (or, more correctly, *ventral*) aspect of the heart.

7 *a*. Lateral view of same heart, right side.

7 *b*. Posterior (or, more correctly *dorsal*) aspect of the same heart.

7 *c*. Lateral view of same heart; left side.

Letters in figs. 5 to 8:—*R. V. C. S*, right vena cava superior; *R. A*, right auricle; *R. V*, right ventricle; *L. V. C. S*, left vena cava superior; *L. A*, left auricle; *L. V*, left ventricle; *P. A*, pulmonary artery; *P. V*, pulmonary vein; *Ao*, aorta; *V. C. I*, vena cava inferior.

8. Dorsal aspect of the same heart, the right auricle being opened and the cut walls reflected, in order to show the inner surface. *Cæ*, oval orifice of the cæcal appendix, mistaken hitherto for a fossa ovalis; *F. O*, position of fossa ovalis in hearts of Placentalia; *V. C. I*, orifice of the vena cava inferior; *L. V. C. S*, orifice of the left vena cava superior; *R. V. C. S*, orifice of the right vena cava superior; *A. V. a*, auriculo-ventricular aperture.

Fig. 9. Right auriculo-ventricular valve of *Phalangista*. *a*, *b*, anterior musculi papillares.

10. Ditto of *Phascolumys*. Letters as before.

11. Ditto of *Mus*. Letters as before.

PLATE XL.

Fig. 12. ORNITHORHYNCHUS No. 1. Right ventricle opened and its anterior wall reflected so as to expose the valve.

a, great or anterior muscular column (musculus papillaris); *b*, right muscular column (musculus papillaris); *e*, left or "conus" muscular column; *P. A.*, orifice of pulmonary artery; *R. A.*, right auricle; *R. V. C. S.*, right vena cava superior; *A.*, aorta.

13. ORNITHORHYNCHUS No. 2. Similar dissection of a second specimen.

a, great or anterior muscular column; *b, b, b*, the three slips which represent the single column *b* of specimen No. 1; *m, n*, two additional muscular columns in the same region, which do not traverse the membranous part of the valve, but pass from the centre of the right muscular arch to the anterior wall of the ventricle, from connexion with which they have been cut, leaving the bases *m', n'*; *x, y*, "columnæ carneæ" connecting the base of the great muscular column with the anterior ventricular wall; *x', y'*, the cut bases of the same; *e*, left muscular column; *P. A.*, orifice of pulmonary artery.

14. ORNITHORHYNCHUS No. 1. The great anterior column cut and the valve reflected. Letters as in fig. 12.

15. ORNITHORHYNCHUS No. 1. Both the great and the right muscular columns are cut. Compare with the human heart, fig. 2.

Letters as in fig. 12, except *la c*, left anterior portion of the membrane of the valve; *rac*, right anterior portion of ditto; *pc*, posterior or septal portion of ditto.

16. ORNITHORHYNCHUS No. 2. The second heart (that of fig. 13) with its muscular columns cut and the valve reflected.

a, base of the great muscular column; *a'*, its cut and reflected ostial portion; *b, b*, bases of two of the right small muscular columns; *b', b'*, their cut ostial portions; *e*, left muscular column; *la c*, left anterior portion of the membrane of the valve; *rac* right anterior portion of ditto; *pc*, the very minute posterior or septal rudiment of ditto.

17. View of the left auriculo-ventricular valve of *Ornithorhynchus*. The apex of the ventricle has been cut away; and the observer is supposed to look upwards towards the aortic and auricular orifices. *ebd*, three muscular columns (papillary muscles) giving attachment to the valve; *cor*, corpuscles resembling the corpuscula Arantii, at the central point of the margin of each flap of the triradiate valve; *L. A.*, left auricle; *Ao*, aortic orifice.

PLATE XLI.

Fig. 18. Right auriculo-ventricular valve of *Didelphys*. *a*, equivalent of the great anterior papillary muscle of Man; *b*, equivalents of the right anterior papillary muscle of Man.

19. Ditto of *Phascolarctos*.

20. Ditto of *Myrmecophaga*. *c*, as in fig. 1.

21. Ditto of *Erinaceus*.

22. Ditto of *Cuscus*.